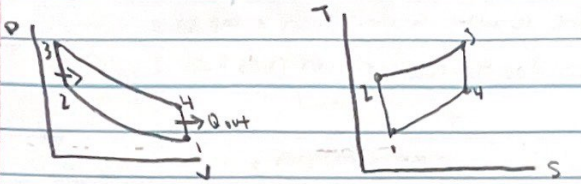
HW 1.3 - KAYLA DAVIES - MET 350

9-33



$r_c = 8$

isentropic	CV	isentrop.	CV
①	②	③	④
$P_1 = 95$ kPa	$v_{r_2} = \frac{v_2}{v_1} v_{r_1}$	$Q_{in} = 750$	$v_{r_4} = 52.7$
$T_1 = 300$ K	$T_2 = 673.1$ K	$U_3 = 1241.2$	$T_4 = 774.5$
$v_1 = 214.01$ kJ/kg	$v_2 = 491.2$	$T_3 = 1539$ K	$U_4 = 571.69$ kJ/kg
$v_{r_1} = 621.2$	$P_2 = 1705$ kPa	$v_{r_3} = 6.588$	
		$P_3 = 3898$ kPa	

$v_{r_2} = \frac{1}{8} \times 621.2 = 77.65$

$P_2 = \frac{v_1}{v_2} \times \frac{T_2}{T_1} \times P_1 = 8 \times \frac{673.1}{300} \times 95 = 1705$ kPa

$Q_{in} = v_3 - v_2 = 493.2 + 750 = 1241.2$ kJ/kg

$P_3 = T_3/T_2 \times P_2 = \frac{1539}{673.1} \times 1705 = 3898$ kPa

$v_{r_4} = 8 \times 6.588 = 52.7$

a) $P_3 = 3898$ kPa, $T_3 = 1539$ K

b) $w_{net,out} = Q_{in} - Q_{out}$

$Q_{out} = u_4 - u_1 = 591.69 - 214.07 = 357.62$ kJ/kg

$750 - 357.62 = \boxed{392.4 \text{ kJ/kg}}$

c) $\eta_{TH} = \frac{w_{net}}{Q_{in}} = 392.4/750 = .5232$ or $\boxed{52.3\%}$

d) $MEP = \frac{w_{net,out}}{v_1 - v_2}$

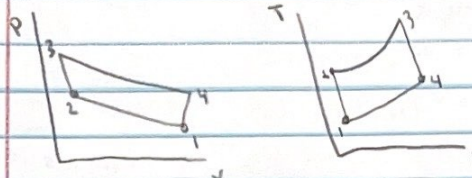
$v_1 = \frac{RT_1}{P_1} = \frac{0.287 \times 300}{95} = 0.906$ m³/kg

$v_2 = \frac{RT_2}{P_2} = \frac{0.287 \times 673.1}{1705} = 0.113$ m³/kg

$MEP = \frac{392.4}{0.906 - 0.113} = \boxed{495 \text{ kPa}}$

HW 1.3 - KD

9-36



d = 3.5 in *Find Power*

L = 3.9 in Otto cycle

V_c = 9.8%

N = 2500 rpm n = 2500/2 = 1250

① isentrop ② CV ③ isentrop ④ CV

P_1 = 14 psia V_2 = 10.204 T_3 = 1588 K ?

T_1 = 313 K $T_2 = 105 \times 10.204^{k-1}$

T_2 = 265.88 F

T_2 = 403 K

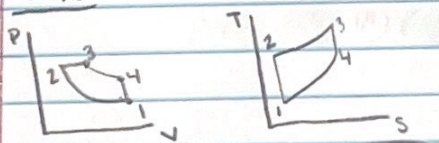
$Q_s = m_{cv}(T_3 - T_2) = 0.1716(1588 - 403) = 20.33$ btu/lbm

$\eta_{TH} = 1 - \left(\frac{1}{10.204^{1.4-1}}\right) = 0.605$ or 60.5%

$0.605 = \frac{W_{net}}{20.33}$ ∴ $W_{net} = 12.3$ btu/lbm

$\text{Power} = \frac{W_{net} \times N \times k}{60} = \frac{12.3 \times 1250 \times 6}{60} = \boxed{1537.5 \text{ btu/s}}$

9-46



$r_v = 16 = V_1/V_2$

$r_c = 2 = V_3/V_2$

① isentrop ② CP ③ isentrop ④ CV

T_1 = 300 K T_2 = 300 K ? ?

P_1 = 95 kPa

a) $T_3 = T_2\left(\frac{r_v^k - 1}{r_c^k - 1}\right) = 300\left(\frac{16^{1.4-1} - 1}{2^{1.4-1} - 1}\right) = \boxed{1907.4 \text{ K}}$

b) $\eta_{TH,DIESEL} = 1 - \left(\frac{1}{r_v^k - r_c^{k-1}}\right)\left(\frac{k-1}{r_v - 1}\right)$

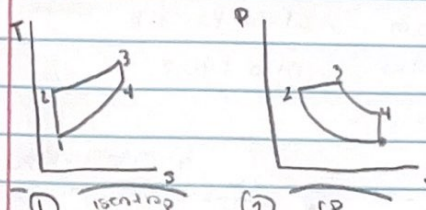
$= 1 - \left(\frac{1}{16^{1.4} - 2^{1.4-1}}\right)\left(\frac{1.4-1}{16-1}\right) = 0.99$ or $\boxed{99\%}$

c) $P = \frac{P_1 V_1}{r_v - 1} \times \frac{r_c^k - 1}{k \times r_c^k - 1}$

$= \frac{95 \times 1000}{16 - 1} \times \frac{2^{1.4} - 1}{1.4 \times 16^{1.4} - 1} = \boxed{675.9 \text{ kPa}}$

HW 1.3 - KD

9-57



diesel cycle

$r_c = 1.8 = v_3/v_2$

$r_v = 22 = v_1/v_2$

① isentrop ② CP ③ isentrop ④ CV

$T_1 = 343\ K$

$P_1 = 97\ kPa$

$v_1 = \frac{RT}{P}$

$v_1 = \frac{0.287 \times 343}{97}$

$v_1 = 1.0149$

$v_2 = \frac{1.0149}{22}$

$v_2 = 0.046$

$T_2 = 343 \times 22^{1.4-1}$

$T_2 = 1181.03\ K$

$P_2 = P_3$

$P_3 = \frac{RT_2}{v_2}$

$P_3 = \frac{0.287 \times 1181.04}{0.04613}$

$P_3 = 7347.9\ kPa$

$v_3 = 1.8 \times 0.046 = 0.08303$

$T_3 = \frac{Pv}{R} = \frac{7347.9 \times 0.08303}{0.287}$

$T_3 = 2125.7\ K$

$T_4 = (v_3/v_1)^{1.4-1}$

$T_4 = 780.9$

$w_{1-2} = -C_v(T_2 - T_1)$

$= -0.718(1181.03 - 343) = -601.71\ kJ/kg$

$w_{2-3} = P_3(v_3 - v_2)$

$= 7347.9(0.08303 - 0.046) = 271.1\ kJ/kg$

$w_{4-1} = 0$ $\quad w_{3-4} = 0.718(2125.77 - 780.95) = 965.56\ kJ/kg$

$P = w_{net}\frac{N}{60}$

$w_{net} = m(w_{1-2} + w_{2-3} + w_{3-4} + w_{4-1})$

$m = \frac{v_d}{v_1} = \frac{2.4E-3}{1.0149} = 2.365E-3$

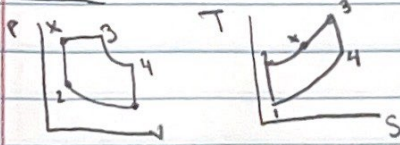
$= 2.365E-3(-601.71 + 271.1 + 965.6 + 0)$

$w_{net} = 1.5\ kJ$

$P = 1.5\left(\frac{3600}{60}\right) = 87.5\ kW$

HW 1.3 - KD

9-59E



① isentrop ② CV (x) CP ③ isentrop ④ CV

$P_1 = 14.1$ psia	$T_2 = 297(16)^{1.4-1}$	$T_x = (1.1)(877.39)$	$T_3 = \rho T_x$	$T_4 = \alpha\beta T_1 = 1.1 \times 1.4^{1.4} \times 297$
$T_1 = 297$ K	$T_2 = 877.39$	$T_x = 965.13$ K	$T_3 = 1351.9$ K	$T_4 = 523.27$ K

a) $w_{net} = q_{in} - q_{out}$

$= 451.1 - C_v(T_4 - T_1) \Rightarrow 451.1 - 0.718(523.27 - 297) = \boxed{288.63 \text{ kJ/kg}}$

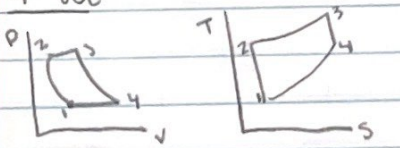
b) $= C_v(T_x - T_2) + C_p(T_3 - T_x)$

$= 0.718(965.13 - 877.39) + 1.005(1351.19 - 965.13)$

$= \boxed{451.1 \text{ kJ/kg}}$

c) $\eta_{TH} = \frac{w_{net}}{q_{in}} = \frac{288.63}{451.1} = 0.639$ or $\boxed{63.9\ \%}$

9-80E



$r_p = 10$

① isentrop ② CP ③ isentrop ④ CP

$T_1 = 520$ R	$P_{r_2} = 1.2147(10)$	$T_3 = 2000$ R	$P_{r4} = \frac{1}{10} \times 167.1$
$h_1 = 124.27$	$P_{r_2} = 12.147$	$h_3 = 504.7$	$P_{r4} = 16.71$
$P_{r_1} = 1.2147$	T_2	$P_{r_3} = 174$	$h_4 = 611.451$
	$h_2 = 240.1$		

a) $T_2 = (980) + \frac{1000-900}{12.30-11.43} \times (12.417 - 11.43) = \boxed{996.5 \text{ R}}$ (table)

b) $r_{bw} = \frac{w_c}{w_T} = \frac{115.8}{238.9} = \boxed{0.4847}$

$w_c = h_2 - h_1 = 124.27 - 240.1 = 115.8$

$w_T = h_3 - h_4 = 504.7 - 265.8 = 238.9$

c) $\eta_{TH} = \frac{w_{net}}{q_{in}}$ $\quad w_{net} = w_c + w_T = -115.8 + 238.9 = 123.1$

$q_{in} = h_3 - h_2 = 504.7 - 240.1 = 264.6$

$\eta_{TH} = \frac{123.1}{264.6} = 0.4652$ or $\boxed{46.5\ \%}$